Ch2 - Measurement

Things to measure

	Base Units
Length -	meters (m)
mass -	grams (g)
time -	(s)

fundamental

Volume - cm^3, Liters (L)

Density - $\left(\frac{g}{cm^3}\right)$

Temperature (°C, K)

Derived

Base
meter
gram
liter

deci hecto
centi kilo
milli deca

smaller

Base
meter
gram
liter

deci hecto
centi kilo
milli deca

smaller →

Base deci
(d)
meter
gram
liter

deci hecto
centi kilo
milli deca

smaller

Base deci
(d)

meter
gram
liter

2m 20dm

deci hecto
centi kilo
milli deca

smaller →

Base deci (d) centi (c)

meter

gram

liter

2m 20dm

deci hecto

centi kilo

milli deca

smaller →

Base	deci (d)	centi (c)	milli (m)
meter			
gram			
liter			
2m	20dm	200cm	2000mm

deci hecto
centi kilo
milli deca

larger ← → smaller

Base	deci (d)	centi (c)	milli (m)
meter			
gram			
liter			
2m	20dm	200cm	2000mm

deci hecto
centi kilo
milli deca

larger ← → smaller

deca (da)	Base	deci (d)	centi (c)	milli (m)
	meter			
	gram			
	liter			
	2m	20dm	200cm	2000mm

~~deci~~ hecto
~~centi~~ kilo
~~milli~~ deca

← larger   smaller →

deca (da)	Base	deci (d)	centi (c)	milli (m)
	meter			
	gram			
	liter			
0.2dam	2m	20dm	200cm	2000mm

~~deci~~ hecto
~~centi~~ kilo
~~milli~~ deca

	← larger		smaller →		
hecto (h)	deca (da)	Base meter gram liter	deci (d)	centi (c)	milli (m)
0.02hm	0.2dam	2m	20dm	200cm	2000mm

~~deci~~ hecto
~~centi~~ kilo
~~milli~~ ~~deca~~

← larger smaller →

kilo (k)	hecto (h)	deca (da)	Base meter gram liter	deci (d)	centi (c)	milli (m)
0.002 km	0.02 hm	0.2 dam	2 m	20 dm	200 cm	2000 mm

~~deci~~ hecto
~~centi~~ kilo
~~milli~~ ~~deca~~

larger ←　　　　smaller →

kilo (k)　hecto (h)　deca (da)　Base　deci (d)　centi (c)　milli (m)

7 cm = ___?___ dam

larger ← → smaller

kilo (k) hecto (h) deca (da) Base deci (d) centi (c) milli (m)

Dimensional Analysis

7 cm = ___?___ dam

larger ← → smaller

kilo (k) hecto (h) deca (da) Base deci (d) centi (c) milli (m)

$7 \text{ cm} = \underline{\ ?\ } \text{ dam}$

Dimensional Analysis

Step 1 -

larger ← → smaller

kilo (k) hecto (h) deca (da) Base deci (d) centi (c) milli (m)

7 cm = ___?___ dam

Dimensional Analysis

Step 1 - multiply given by a fraction.

larger ← → smaller

kilo (k) hecto (h) deca (da) Base deci (d) centi (c) milli (m)

7 cm = ___?___ dam

7 cm × ________

Dimensional Analysis

Step 1 - multiply given by a fraction.

larger ← → smaller

kilo (k) hecto (h) deca (da) Base deci (d) centi (c) milli (m)

7 cm = ___?___ dam

7cm × ________

Dimensional Analysis

Step 1 - multiply given by a fraction.

Step 2 - put units in fraction
convert to → top
" from → bottom

larger ← → smaller

kilo (k) hecto (h) deca (da) Base deci (d) centi (c) milli (m)

$7\ cm = \underline{\ ?\ }\ dam$

$7\ cm \times \frac{dam}{cm} =$

Dimensional Analysis

Step 1 - multiply given by a fraction.

Step 2 - put units in fraction
convert to → top
" from → bottom

larger ← → smaller

kilo (k) hecto (h) deca (da) Base deci (d) centi (c) milli (m)

7 cm = ___?___ dam

$7\,\cancel{cm} \times \frac{dam}{\cancel{cm}} =$ dam

Dimensional Analysis

Step 1 - multiply given by a fraction.

Step 2 - put units in fraction
convert to → top
" from → bottom

larger ← · smaller →

kilo (k) · hecto (h) · deca (da) · Base · deci (d) · centi (c) · milli (m)

7 cm = ___?___ dam

$7\,\cancel{cm} \times \frac{dam}{\cancel{cm}} =$ dam

Dimensional Analysis

Step 1 - multiply given by a fraction.

Step 2 - put units in fraction
convert to → top
" from → bottom

Step 3

larger ← → smaller

kilo (k) hecto (h) deca (da) Base deci (d) centi (c) milli (m)

Dimensional Analysis

$7 \text{ cm} = \underline{\ ?\ } \text{ dam}$

$7 \cancel{\text{cm}} \times \frac{\text{dam}}{\cancel{\text{cm}}} = \quad \text{dam}$

Step 1 - multiply given by a fraction.

Step 2 - put units in fraction
convert to → top
" from → bottom

Step 3 (Metric only)
put a 1 in front of Bigger unit

larger ← → smaller

kilo (k) hecto (h) deca (da) Base deci (d) centi (c) milli (m)

$7\ cm = \underline{\ ?\ }\ dam$

$7\ \cancel{cm} \times \frac{1\ dam}{\cancel{cm}} = \qquad dam$

Dimensional Analysis

Step 1 - multiply given by a fraction.

Step 2 - put units in fraction
convert to → top
" from → bottom

Step 3 (Metric only)
put a 1 in front of Bigger unit

larger ←   smaller →

kilo (k)   hecto (h)   deca (da)   Base   deci (d)   centi (c)   milli (m)

7 cm = ___?___ dam

$7\,\cancel{cm} \times \frac{1\ dam}{1000\ \cancel{cm}} =$ dam

Dimensional Analysis

Step 1 - multiply given by a fraction.

Step 2 - put units in fraction
convert to → top
" from → bottom

Step 3 (Metric only)
put a 1 in front of Bigger unit

Step 4 - In front of other unit put a power of 10 that corresponds to how far apart the 2 units are.

larger ← → smaller

kilo (k) hecto (h) deca (da) Base deci (d) centi (c) milli (m)

$7\ cm = \underline{\ ?\ }\ dam$

$7\ \cancel{cm} \times \frac{1\ dam}{1000\ \cancel{cm}} = 0.007\ dam$

Dimensional Analysis

Step 1 - multiply given by a fraction.

Step 2 - put units in fraction
convert to → top
" from → bottom

Step 3 (Metric only)
put a 1 in front of Bigger unit

Step 4 - In front of other unit put a power of 10 that corresponds to how far apart the 2 units are.

21 hL = $\underline{\ ?\ }$ mL

21 hL

21 hL = ___?___ mL

21 hL x ________

$21\,hL = \underline{\quad ? \quad}\,mL$

$21\,hL \times \frac{mL}{hL}$

$21\,hL = \underline{\ ?\ }\,mL$

$21\,hL \times \frac{mL}{1\,hL}$

$21\,hL = \underline{\ ?\ }\,mL$

$21\,hL \times \frac{100000\,mL}{1\,hL}$

$21\,hL = \underline{\ ?\ }\,mL$

$21\,h\cancel{L} \times \frac{100000\,mL}{1\,h\cancel{L}} = 2100000\,mL$

Accuracy

Precision

Accuracy – how close a measured value is to the actual value

Precision - how close a series of measurements are to each other

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Precision - how close a series of measurements are to each other

Repeatability of measurement

Calculating Precision

Calculating Precision

↳ Missy

5.01 g
4.99 g

Calculating Precision

↳ Missy

5.01 g

4.99 g

5.00 g

Calculating Precision

Misty	Gaspar
5.01 g	5.24g
4.99 g	4.88 g
5.00g	5.14g

Calculating Precision

Misty	Gaspar
5.01 g	5.24 g
4.99 g	4.88 g
5.00 g	5.14 g

Calc Precision

$$\text{Avg} \pm \frac{\text{Range}}{2}$$

Calculating Precision

Missy	Gaspar
5.01 g	5.24 g
4.99 g	4.88 g
5.00 g	5.14 g

5.00 g

Avg

Calc Precision

$$Avg \pm \frac{Range}{2}$$

Calculating Precision

Misty	Gaspar
5.01 g	5.24g
4.99 g	4.88 g
5.00 g	5.14g

Range: 0.02g

$\frac{\text{Range}}{2}$ = 0.01g

5.00g

Avg

Calc Precision

$\text{Avg} \pm \frac{\text{Range}}{2}$

Calculating Precision

	Missy	Gaspar
	5.01 g	5.24g
Range: 0.02g	4.99 g	4.88 g
	5.00 g	5.14g

$\frac{\text{Range}}{2} = 0.01g$

$\boxed{5.00g \pm 0.01g}$

$\text{Avg} \pm \frac{\text{Range}}{2}$

Calc Precision

$\text{Avg} \pm \frac{\text{Range}}{2}$

Calculating Precision

Missy	Gaspar
5.01 g	5.24g
4.99 g	4.88 g
5.00 g	5.14g
	5.09g

Range: 0.02g

$\frac{\text{Range}}{2} = 0.01g$

$\boxed{5.00g \pm 0.01g}$

$\text{Avg} \pm \frac{\text{Range}}{2}$

Calc Precision

$\text{Avg} \pm \frac{\text{Range}}{2}$

Calculating Precision

Missy	Gaspar
5.01 g	5.24 g
4.99 g	4.88 g
5.00 g	5.14 g

Range: 0.02 g

$\frac{\text{Range}}{2} = 0.01\text{g}$

$\boxed{5.00\text{g} \pm 0.01\text{g}}$

R = 0.36 g

$\frac{R}{2} = 0.18$ g

$5.09\text{g} \pm 0.18\text{g}$

Calc Precision

$\text{Avg} \pm \frac{\text{Range}}{2}$

$\text{Avg} \pm \frac{\text{Range}}{2}$

Calculating Precision

	Missy	Gaspar	
	5.01 g	5.24 g	R = 0.36 g
Range: 0.02 g	4.99 g	4.88 g	$\frac{R}{2}$ = 0.18 g
$\frac{\text{Range}}{2}$ = 0.01 g	5.00 g	5.14 g	

$\boxed{5.00\text{g} \pm 0.01\text{g}}$ $\boxed{5.09\text{g} \pm 0.18\text{g}}$

Calc Precision

$\text{Avg} \pm \frac{\text{Range}}{2}$

$\text{Avg} \pm \frac{\text{Range}}{2}$

Less Prec. w/ Gaspar
B/c $\pm \frac{\text{Range}}{2}$ is larger

Calculating Accuracy

Calculating Accuracy

$\downarrow$

% Error

supposed to get 25.0g

Calculating Accuracy

↓

% Error

supposed to get 25.0g

actually got 20.2g

Calculating Accuracy

$$\% \text{ Error} = \frac{\text{obs val} - \text{actual value}}{\text{actual value}} \times 100\%$$

supposed to get 25.0g

actually got 20.2g

Calculating Accuracy

Experimental

$$\% \text{ Error} = \frac{\left| \text{obs val} - \text{actual value} \right|}{\text{actual value}} \times 100\%$$

supposed to get 25.0g

actually got 20.2g

Calculating Accuracy

$$\boxed{\% \text{ Error} = \frac{\left| \overset{\text{Experimental}}{\text{obs val}} - \text{actual value} \right|}{\text{actual value}} \times 100\%}$$

supposed to get 25.0g

actually got 20.2g

Calculating Accuracy

$$\% \text{ Error} = \frac{\left|\overset{\text{Experimental}}{\text{obs val}} - \text{actual value}\right|}{\text{actual value}} \times 100\%$$

supposed to get 25.0g

actually got 20.2g

$$\frac{|20.2g - 25.0g|}{25.0g} \times 100\% = \boxed{19.2\%}$$

6.022 0000000000000000000000 atoms

6.0220000000000000000000000 atoms

0.0000000000000000000000000009109 g

6.022 00000000000000000000 atoms

0.0000000000000000000000000009109 g

$6.022\,00000000000000000000$ atoms

Scientific Notation $\longrightarrow$ 6.022×10^{23} atoms

$0.0000000000000000000000000009109$ g

9.109×10^{-28} g

1400

0.00000641

0.00083

19010000

1.400. → 1.4 x10

0.00000641

0.00083

19010000

1400. $\rightarrow$ 1.4×10^3

0.00000641

0.00083

19010000

1.400. $\rightarrow$ 1.4×10^{3}

0.00000641

0.00083 $\rightarrow$ 8.3×10^{-4}

19010000

$1400. \rightarrow 1.4 \times 10^3$

0.00000641

$0.00083 \rightarrow 8.3 \times 10^{-4}$

$19010000 \rightarrow 1.901 \times 10^7$

1400. $\rightarrow$ 1.4×10^{3}

0.00000641

6.41×10^{-6}

0.00083 $\rightarrow$ 8.3×10^{-4}

19010000 $\rightarrow$ 1.901×10^{7}

Proportions

Proportions

Direct Proportions

Proportions

Direct Proportions

If $x \uparrow$, $y \uparrow$ proportionately by a constant (k)

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If $x \uparrow$, $y \uparrow$ proportionately by a constant (k)

$$y = kx$$

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Proportions

Direct Proportions

If $x \uparrow$, $y \uparrow$ proportionately by a constant (k)

$$y = kx \quad \text{or} \quad k = \frac{y}{x}$$

Proportions

Direct Proportions

If $x \uparrow$, $y \uparrow$ proportionately by a constant (k)

$$y = kx \quad \text{or} \quad k = \frac{y}{x}$$

Graph →

Proportions

Direct Proportions

If $x \uparrow$, $y \uparrow$ proportionately by a constant (k)

$$y = kx \quad \text{or} \quad k = \frac{y}{x}$$

Graph →

Proportions

Direct Proportions

If $x \uparrow$, $y \uparrow$ proportionately by a constant (k)

$$y = kx \quad \text{or} \quad k = \frac{y}{x}$$

Graph →

Ex: Density

$$D = \frac{m}{V}$$

Proportions

Direct Proportions

If $x \uparrow$, $y \uparrow$ proportionately by a constant (k)

$$y = kx \quad \text{or} \quad k = \frac{y}{x}$$

Graph →

Ex: Density

$$D = \frac{m}{V}$$

V & Pressure of a gas

Inverse Proportions

Inverse Proportions

If $x\uparrow$, $y\downarrow$ proportionally by a constant

$$K = xy$$

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Inverse Proportions

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Graph

Inverse Proportions

If $x\uparrow$, $y\downarrow$ proportionately by a constant

$K = xy$

Ex: speed vs frequency & wavelength

Graph

Inverse Proportions

If $x\uparrow$, $y\downarrow$ proportionally by a constant

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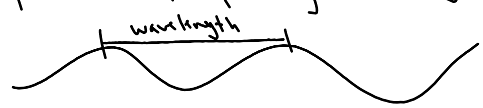
Graph

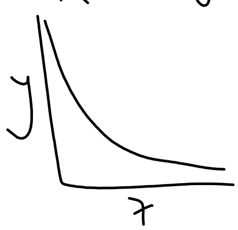


Inverse Proportions

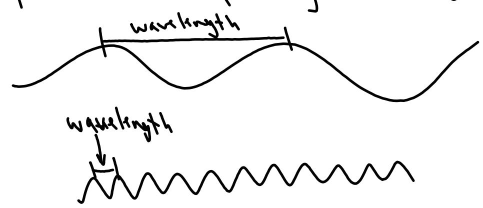
If $x\uparrow$, $y\downarrow$ proportionally by a constant

$$K = xy$$

Graph



Ex: speed vs frequency & wavelength



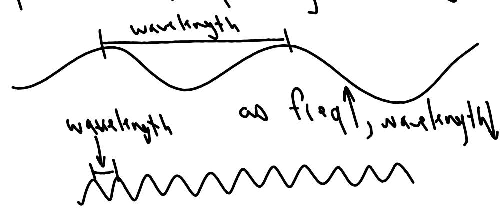
Inverse Proportions

If $x\uparrow$, $y\downarrow$ proportionally by a constant

$$K = xy$$

Graph

Ex: Speed vs frequency & wavelength



Problem solving
w/ Equations

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w/ Equations

Density $\longrightarrow$ $D = \frac{m}{V}$

Problem solving
w/ Equations

Density $\longrightarrow$ $D = \frac{m}{V}$

A rock is measured to have a mass of 273 g and a 20.0 mL. what is the Density?

Problem solving
w/ Equations

Density → $D = \frac{m}{V}$

A rock is measured to have a mass of 273 g and a 20.0 mL. what is the Density?

The mass of a
copper ingot is
28.0g, what is the
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$D_{Cu} = 8.93 \frac{g}{cm^3}$

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$D = \frac{m}{V}$

The mass of a copper ingot is 28.0g, what is the volume of the sample?

$D_{Cu} = 8.93 \frac{g}{cm^3}$

$D = \frac{m}{V}$

$V = \frac{m}{D}$

The mass of a copper ingot is 28.0g, what is the volume of the sample?

$D_{Cu} = 8.93 \frac{g}{cm^3}$

$D = \frac{m}{V}$

$V = \frac{m}{D} = \frac{28.0g}{8.93\frac{g}{cm^3}}$

The mass of a copper ingot is 28.0g, what is the volume of the sample?

$D_{Cu} = 8.93 \frac{g}{cm^3}$

$D = \frac{m}{V}$

$V = \frac{m}{D} = \frac{28.0\cancel{g}}{8.93\frac{\cancel{g}}{cm^3}} = 3.13\ cm^3$

Measuring Volume

Measuring Volume

Dimensions

↳ $V = L \times w \times h$

(of a Box / cube)

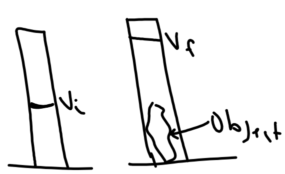
Measuring Volume

Dimensions

↳ $V = L \times w \times h$

(of a Box/cube)

Water Displacement



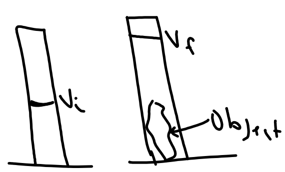
Measuring Volume

Dimensions

↳ $V = L \times w \times h$

(of a Box / cube)

Water Displacement



$V_{obj} = V_f - V_i$

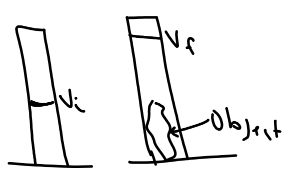
Measuring Volume

Dimensions

↳ $V = L \times w \times h$

(of a Box/cube)

Water Displacement



$V_{obj} = V_f - V_i$

A sample of Copper is placed in a graduated cylinder w/ an initial volume of H_2O being 543 mL. If the volume of water rises to 655 mL what is the mass of the Cu sample?

$m = V \times D$

A sample of Copper is placed in a graduated cylinder w/ an initial volume of H_2O being 543 mL. If the volume of water rises to 655 mL what is the mass of the Cu sample?

A sample of Copper is placed in a graduated cylinder w/ an initial volume of H_2O being 543 mL. If the volume of water rises to 688 mL what is the mass of the Cu sample?

$m = V \times D$

$V = 688\,mL - 543\,mL = 145\,mL$

$m =$

$m = V \times D$

$V = 688\,mL - 543\,mL = 145\,mL$

$m = (145\,\cancel{mL})\left(8.93\,\frac{g}{\cancel{mL}}\right) =$

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$m = V \times D$

$V = 688\,mL - 543\,mL = 145\,mL$

$m = (145\,\cancel{mL})\left(8.93\,\frac{g}{\cancel{mL}}\right) = 1295\,g$